

PATENT CLAIMS

1. A procedure for extracting information from a phonocardiographic signal obtained from a transducer and subjected to signal processing,
 5 characterised in that first and second heart sounds are detected and placed correctly on a time axis by performing the steps of feature extraction and classification based on the energy distribution over time in a feature time function by the steps of bandpass filtering, followed by instantaneous power and lowpass filtering of the original phonocardiographic signal.
- 10 2. A procedure for extracting information from a phonocardiographic signal according to claim 1, including identification of characteristic signal components, characterised in that it comprises the following steps:
 - extracting the first and second heart sounds by classification according to energy
 15 levels,
 - eliminating the contribution of the said first and second heart sounds from the signal,
 - performing spectral analysis and feature enhancement in order to obtain the energy content present in areas of a time-frequency representation delimited by frequency
 20 band times time interval in the form of energy distributions
 - classifying the energy distributions according to pre-defined criteria
 - comparing the energy distributions to a catalogue of distributions related to known medical conditions.
- 25 3. A procedure used for extracting murmur information, characterised in that it comprises the following steps:
 - obtaining a digital representation of heart sound for a predetermined number of seconds,
 - identifying the time of occurrence of the first and second heart sounds in each cycle,
 30 - windowing the parts of heart sounds falling between the first and second heart sounds, and second and first heart sounds, respectively
 - decomposition of the signals into a predetermined first number n1 of frequency bands, each band being decomposed into a predetermined second number n2 of time-slices

- obtaining a systole (SP) and a diastole (DP) power vector consisting of the sum of n_1 powers measured in each of the n_2 time slices
- for each combination of a frequency band and a time slice, the power values from the different systoles are compared, and the median value is chosen to be the
5 standard value for a power vector
- obtaining a systole (SMF) and a diastole (DMF) mean frequency vector by weighting the power value for each of n_1 frequency bands with the mean frequency of the corresponding band, summing the results and dividing the sum by the corresponding element in the respective systole or diastole power vector
- 10 - while using the time of occurrence of the intensity vectors of the various classes for classifying the time distribution of murmurs.

4. A procedure for extracting murmur information according to claim 3, characterised in that a step preceding the step of obtaining systole and
15 diastole murmur intensity vectors SI and DI consists of refining the windowing by setting the values of SP, DP, SMF, and DMF of the first or last elements equal to the second or last-but-one values, respectively, if the values of the first or last elements of the corresponding vectors fulfil predetermined deviation criteria.

20 5. A procedure according to claim 3, characterised in that further steps are included in the procedure, comprising

- subjecting the signal to double differentiation before decomposition
- obtaining a systole (SI) and diastole (DI) murmur intensity vector, respectively, by taking the logarithm of the corresponding SP and DP vectors,
- 25 - classifying the obtained logarithmic vectors into murmur intensity classes
- comparing the energy distributions to a catalogue of distributions related to known medical conditions.

30 6. An apparatus for performing the procedure according to claim 1, characterised in that it comprises analog-to-digital means for converting a heart sound signal into sampled data, means for extracting the first and second heart sounds by classification according to energy levels, means for eliminating the contribution of the said first and second heart sounds from the signal, means for performing spectral analysis, means for performing feature enhancement, and

multiplication means for obtaining the energy content present in areas of a time-frequency representation delimited by frequency band multiplied by time interval in the form of energy distributions means for classifying the energy distributions according to pre-defined criteria, and comparator means for comparing the energy
5 distributions to a catalogue of distributions related to known medical conditions.

7. An apparatus for performing the procedure according to claim 1, wherein signal processing means are used to produce a spatial sound distribution based on frequency, a low frequency band being delivered to a first earpiece of a headphone
10 and a high frequency band being delivered to a second earpiece of said headphone, the frequency bands containing first and second heart sounds and murmur sounds respectively.

8. An apparatus according to claim 7, wherein said signal processing means
15 produce a temporal sound distribution, sound signals being first delivered to a first earpiece of the headphone and then being delivered to a second earpiece of the headphone.

9. A apparatus according to claim 7 or 8, wherein said signal processing
20 means comprise at least one Wiener filter.